cisco, tells of efforts to protect California fruits from frosts. It is a matter of credit to the Weather Bureau and its California forecasters that during the winter of 1909–10 in that state there was not a single forecast of injurious frost that was not fully verified, and, what is more satisfactory, there was not a single frost injurious to fruit occurring during that period which was not forecast from twelve to thirty-six hours in advance. Efforts are being made to select hardy plants which will resist low temperatures, to render the plant dormant and not sensitive during the cold periods, and also to fight the cold and minimize exposure thereto by producing heat artificially. In the April number Mr. E. M. Gruss, of Houston Heights, Texas, tells of the beneficial effects of smudge fires to protect the fruit and garden crops in the southern part of that state by means of checking the nocturnal radiation. He points out the necessity of rapid action the moment frost is predicted, and also recommends the use of temporary coverings of hay, straw, soil, slatted roofs or mats, or by means of flooding or spraying. At Grand Junction, Col., in the vicinity of which temperatures as low as 15° were observed on the night of April 12 last, ample forecasts were widely disseminated by telephone, and orchard temperatures were kept above the danger point by means of artificial heating. In the same number of the *Review* Dr. P. F. Homer, of Pleasant Grove, Utah, tells of work being done there to determine the resistance of fruit buds to frost and the factors which bring about the remarkable differences noted whereby a freeze will kill one bud on a twig and leave unharmed another one adjacent to it, or will destroy the blossoms on one tree and not affect another of the same species near by. Mr. W. E. Bonnett, local forecaster at Fresno, Cal., also tells of successful efforts in fighting frost in the California vineyards. On April 13, when the most damaging frost in many years occurred near Fresno, and reliable instruments recorded temperatures of 27°, vineyards were protected by means of fire pots in which was burned a specially prepared fuel of sawdust and shavings. He points out the fact that danger from frosts lies within very narrow limits, and states that growers in his vicinity are awakening to the fact that complete protection is easy and sure. In another note Professor McAdie describes a new device called an "antifrost candle," a cartridge which consists of a cylindrical tube containing slow-burning material. These cartridges are suspended in an orchard just beneath the fruit, the ends are lighted, and the heat produced is distributed at the particular level where it is most needed.

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SPECIAL ARTICLES

THE NITROGEN AND HUMUS PROBLEM IN DRY-FARMING

THE Utah Experiment Station has been conducting investigations for several years regarding the effect of crop production, under strictly dry-farming methods, upon the nitrogen and humus content of the soil. A preliminary report[1] of this work was issued last year. The writer found, contrary to the teachings of modern agriculture, that crop production had not caused a decrease in the nitrogen and humus content of the cultivated soil when compared with that of the adjacent virgin soil.

Recently a criticism of this report appeared in SCIENCE[2] written by Mr. C. S. Scofield, of the United States Department of Agriculture. There are two main points in Mr. Scofield's criticism: first, the characteristic cultural methods in vogue in the Cache Valley, Utah, were not emphasized so as to bring out the differences between these and the methods in vogue in the Great Plains area of the United States; second, the noted increase in nitrogen and humus content was not correlated with the yields on the cropped land.

[1] Utah Experiment Station, Bulletin No. 109.

[2] SCIENCE, Vol. XXXIII., No. 855, May 19, 1911, p. 780.

The writer did not bring out the characteristic differences in the cultural methods in vogue in the Cache Valley, Utah, as compared with the cultural methods in vogue in the Great Plains area. Neither did he bring out the differences in cultural methods in vogue in the Cache Valley, Utah, and in Russia. And why should he? He was writing of neither the soils and cultural methods of the Great Plains area of the United States nor of Russia. He was writing a preliminary report of a purely local phase of the general problem and in this connection he said: "The data presented herein are very interesting and instructive, but one must not generalize too much from the limited amount of information furnished. In studying the results, the nature of the soil and cultural methods of Cache Valley should be kept in mind. . . . *Such soils are probably not found in any other extensive dry-farming district outside of Utah.*"[3] In the face of this statement, it seems difficult to see how any one could accuse the writer of attempting to apply these results to the Great Plains area.

The noted increase of nitrogen and humus was not correlated with the yields of wheat because the accurate yields of wheat were not available. The writer felt that the reputed yields of wheat, obtained from the average farmer, whose only record was his memory and who even had no accurate knowledge of the acreage harvested each year, could have but little if any scientific value. The writer felt that a general statement that "Some of the farms of this district have been under cultivation for forty-five years and apparently yield as good crops as they ever did" was fully as valuable. He still feels that this statement is as valuable as Scofield's[4] regarding the yield of wheat in this same section, wherein he says, "While actual comparison is of course impossible, there are reasons for believing that some of these fields are capable of producing better crops now than when first plowed."

[3] Utah Experiment Station, Bul. 109, p. 15.

[4] U. S. Dept. Agr., Bureau of Plant Industry, Bulletin 103, p. 31.

Since the report was only a preliminary one and the investigation was being continued in the Juab Valley on the Nephi Experimental Farm where the accurate record of yields of wheat was available since the establishment of the farm on virgin sagebrush soil, the writer felt that the noted increase of nitrogen and humus could not but be of interest to agronomists and agricultural chemists in itself, leaving to a future publication the correlation of such an increase with the accurate recorded yields of wheat or other crops.

The investigations on the Nephi Farm have been completed and the results are given herewith. The virgin soil was obtained at the time of the location of the farm in 1903. The samples of virgin soil are composites of twenty-five separate borings on a forty acre tract, so they fairly represent the composition of the soil of the farm in its virgin state.

The samples from plots 82, 83 and 144 were obtained in 1910, seven years after commencement of cultivation. Each sample is a composite of two separate borings.

TABLE I. NITROGEN, HUMUS AND ORGANIC CARBON IN CULTIVATED AND VIRGIN SOIL

Results reported as per cent. of dry soil

Treatment	Depth in Inches	Nitrogen	Humus[5]	Organic Carbon[6]
Virgin soil of farm.....	0–12	0.116	1.34	0.315
	12–24	0.103	0.89	0.436
Continuous cropped, plot 82.....	0–12	0.117	1.39	0.558
	12–24	0.092	0.91	0.477
Alternate cropped and fallow, plot 83.....	0–12	0.108	1.01	0.611
	12–24	0.065	0.78	0.440
Alfalfa, plot 144...	0–12	0.110	1.33	0.599
	12–24	0.095	1.38	0.392

The nitrogen and organic carbon have not decreased in the cropped soil when compared with the composition of the same soil in its virgin state. The difference in results for nitrogen in the cropped and virgin soil is

[5] By method of Mooers and Hampton, *Jr. Am. Chem. Soc.*, 1908, Vol. 30, p. 805.

[6] By method of Pettit and Schaub, *Jr. Am. Chem. Soc.*, 1904, Vol. 26, p. 1640.

within the experimental error of sampling and analysis. The total organic carbon has markedly increased in the cropped soil. The "humus" has remained practically the same except on the alternate cropped and fallow plot where a decrease has occurred.

The yearly yields of the plots since the beginning of crop production on this farm are recorded in Table II.

TABLE II. YIELD OF WHEAT ON PLOTS CROPPED CONTINUOUSLY AND ALTERNATELY CROPPED AND SUMMER-FALLOWED

Yield of wheat reported as bushels per acre

Plot No.	1904	1905	1906	1907	1908	1909	1910
82	17.75	8.9	17.9	16.5	13.4	14.58	7.8
83	15.16	fallow	35.6	fallow	32.7	fallow	9.9

The alfalfa plot was utilized for experiments in alfalfa seed production. No yield of seed was obtained. The seed experiment was discontinued in 1908. In 1909 a yield of 2,775 pounds of hay was obtained. The crop failed to mature in 1910.

With respect to the characteristic cultural methods in vogue in Utah, it may be noted that one of the reasons why the grain is harvested with the header is that the straw is so short that it is difficult to use a binder. Wherever a binder is used, the straw is of a ranker growth which permits its use. Now, this being true, it is very doubtful if there be more straw in the stubble on dry-farming land in Utah where the header is used than in the stubble on land where the ranker growth of straw permits the use of the binder. The writer confesses that he knows of no accurate data upon this point.

The explanation of the noted increase of humus and nitrogen in the dry-farming soils of Utah must be sought elsewhere. The effect of the cultural methods, while not of paramount importance, is a possibility which ought not to be ignored. In many sections of the country, such as the Mississippi valley, there is a sharp line of demarkation between the surface soil and subsoil, due to the accumulation of humus in the surface soil formed from the decayed roots of the native grasses and the addition of their residues. The marked change in color of the subsoil indicates that the roots of the native grasses have not penetrated to greater depth. In the soils of Utah, no such line of demarkation occurs between surface and subsoil, which clearly indicates that the roots of the native vegetation have penetrated to great depths. The significance of the deep-rooted character of native plants in arid soil was first noted by Hilgard.[7] The characteristic native vegetation of the dry-farming soils of Utah is sagebrush, the roots of which penetrate to great depths and, being of a woody nature, do not undergo decay rapidly. The foliage is very scant and adds little to the humus-forming material of the soil. The native grasses occasionally occurring with sagebrush are also deep rooted. In a word, there is limited possibility for the formation of humus in the virgin surface soil as compared with other sections of the country where the root system does not penetrate so deep and the native vegetation of a humus-forming type is more abundant. Therefore, in the dry-farming soils of Utah, the addition of *any* straw must increase the organic matter of the plowed surface of the soil as compared with the virgin surface soil which receives little or no organic matter of a humus-forming type. The other factors as noted in Bulletin No. 109 should also be considered in connection with the increase of nitrogen and humus in the cultivated soil.

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[7] "Soils," p. 174.

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